

What is claimed is:

1. A method for use in operating a signal attenuation measurement device, the measurement device including a source system for generating at least first and second signals and for transmitting the first and second signals to a patient tissue site that
5 attenuates the signals, a detector system for receiving at least first and second attenuated signals from the patient tissue site corresponding with the first and second signals transmitted to the patient tissues site and for providing a composite detector signal based on the first and second attenuated signals, and a parameter estimation module for determining a physiological parameter regarding the patient based on information
10 included in the detector signal, said method comprising:
operating the source system to multiplex the first and second signals in accordance with first and second frequency orthogonal code division multiplexed excitation waveforms;
processing the detector signal to provide a processed signal for demultiplexing,
15 the processed signal including information regarding the first and second attenuated signals; and
demultiplexing the processed signal using at least one demultiplexing signal, said at least one demultiplexing signal including a series of values corresponding with one of the first and second frequency orthogonal code division multiplexed waveforms such that
20 said step of demultiplexing the processed signal yields demultiplexed information corresponding to each of the first and second attenuated signals;
wherein said demultiplexed information is usable by the parameter estimation module for determining the physiological parameter regarding the patient.
- 25 2. The method of Claim 1 wherein the physiological parameter is at least one of a blood oxygen saturation value and a blood analyte value.
3. The method of Claim 1 wherein the processed signal is an analog signal and said step of processing comprises converting at least a portion of the processed signal
30 into a series of digital values.

4. The method of Claim 1 wherein each of the first and second signals includes high value time periods and low value time periods and said step of processing the detector signal comprises digitally sampling the detector signal multiple times within a time period corresponding to one of said high value and low value time periods of one
5 of the first and second signals.

5. The method of Claim 1 wherein said step of processing the detector signal comprises filtering the detector signal to remove one or more selected frequency components.

10

6. The method of Claim 1 wherein said step of demultiplexing comprises:
first processing the processed signal using a first demultiplexing signal including a series of values corresponding to the first frequency orthogonal code division multiplexed excitation waveform; and
15 second processing the processed signal using a second demultiplexing signal including a series of values corresponding to the second frequency orthogonal code division multiplexed excitation waveform signal.

7. The method of Claim 1 wherein the first frequency orthogonal code
20 division multiplexed excitation waveform comprises a number of first pattern groups, each first pattern group comprising a plurality of randomly selected values wherein each randomly selected value in a first pattern group corresponds with one of a plurality of pulse patterns selected from a first set of pulse patterns, and wherein the second frequency orthogonal code division multiplexed excitation waveform comprises a
25 number of second pattern groups, each second pattern group comprising a plurality of randomly selected values wherein each randomly selected value in a second pattern group corresponds with one of a plurality of pulse patterns selected from a second set of pulse patterns.

8. The method of Claim 7 wherein each of the pulse patterns within the first set of pulse patterns is substantially orthogonal to each of the pulse patterns within the second set of pulse patterns.

5 9. The method of Claim 7 wherein each of the pulse patterns within the first set of pulse patterns and within the second set of pulse patterns is a digital code comprising a series of high and low values.

10 10. The method of claim 9 wherein the series of high and low values in each of the pulse patterns within the first and second set of pulse patterns are of equal length.

11. The method of Claim 9 wherein the high values in each of the pulse patterns within the first set of pulse patterns do not overlap in time with the high values in each of the pulse patterns within the second set of pulse patterns.

15 12. The method of Claim 7 wherein the first set of pulse patterns includes two different pulse patterns and wherein the second set of pulse patterns includes two different pulse patterns.

20 13. The method of Claim 7 wherein the number of first pattern groups within the first frequency orthogonal code division multiplexed excitation waveform and the number of second pattern groups within second frequency orthogonal code division multiplexed excitation waveform are prime numbers.

25 14. The method of Claim 13 wherein there is a total of three first pattern groups within the first frequency orthogonal code division multiplexed excitation waveform and a total of two second pattern groups within second frequency orthogonal code division multiplexed excitation waveform, and wherein each first pattern group includes four pulse patterns selected from the first set of pulse patterns and each second
30 pattern group includes six pulse patterns selected from the second set of pulse patterns.

15. An apparatus for use in determining at least one physiological parameter relating to a patient from at least first and second signals transmitted to a patient tissue site and attenuated thereby, said apparatus comprising:

5 a source system operative to generate the first and second signals and transmit the first and second signals to the patient tissue site;

a detector system operative to receive first and second attenuated signals from the patient tissue site corresponding with the first and second signals transmitted to the patient tissues site and provide a composite detector signal based on the first and second attenuated signals; and

10 a signal processing device including:

a code generation module operative to drive the source system to multiplex the first and second signals in accordance with first and second frequency orthogonal code division multiplexed excitation waveforms; and

15 a demodulation module operative to demultiplex the composite detector signal using at least one demultiplexing signal, said at least one demultiplexing signal including a series of values corresponding with one of the first and second frequency orthogonal code division multiplexed waveforms to obtain demultiplexed information corresponding to each of the first and second attenuated signals, the demultiplexed information being usable in determining the
20 physiological parameter regarding the patient.

16. The apparatus of Claim 15 wherein the physiological parameter is at least one of a blood oxygen saturation value and a blood analyte value.

25 17. The apparatus of Claim 15 wherein said source system includes first and second light sources operative to transmit first and second light signals centered at first and second wavelengths.

30 18. The apparatus of Claim 17 wherein the first wavelength is within the infrared portion of the electromagnetic spectrum and the second wavelength is within the red portion of the electromagnetic spectrum.

19. The apparatus of Claim 17 wherein the detector system includes a photo-detector.

5 20. The apparatus of Claim 15 wherein the composite detector signal is an analog signal and said detector system includes an analog-to-digital converter operative to convert at least a portion of the detector signal into a series of digital values.

10 21. The apparatus of Claim 20 wherein each of the first and second signals includes high value time periods and low value time periods and said analog-to-digital converter is operative to sample the detector signal multiple times within a time period corresponding to one of said high value and low value time periods of one of the first and second signals.

15 22. The apparatus of Claim 15 wherein said detector system includes an amplifier operative to amplify the detector signal and filter the detector signal to remove one or more selected frequency components.

20 23. The apparatus of Claim 15 wherein said demodulation module demultiplexes the detector signal using a first demultiplexing signal including a series of values corresponding to the first frequency orthogonal code division multiplexed excitation waveform and a second demultiplexing signal including a series of values corresponding to the second frequency orthogonal code division multiplexed excitation waveform signal.

25

24. The apparatus of Claim 15 wherein the first frequency orthogonal code division multiplexed excitation waveform comprises a number of first pattern groups, each first pattern group comprising a plurality of randomly selected values wherein each randomly selected value in a first pattern group corresponds with one of a plurality of pulse patterns selected from a first set of pulse patterns, and wherein the second frequency orthogonal code division multiplexed excitation waveform comprises a

30

number of second pattern groups, each second pattern group comprising a plurality of randomly selected values wherein each randomly selected value in a second pattern group corresponds with one of a plurality of pulse patterns selected from a second set of pulse patterns.

5

25. The apparatus of Claim 24 wherein each of the pulse patterns within the first set of pulse patterns is substantially orthogonal to each of the pulse patterns within the second set of pulse patterns.

10

26. The apparatus of Claim 24 wherein each of the pulse patterns within the first set of pulse patterns and within the second set of pulse patterns is a digital code comprising a series of high and low values.

15

27. The apparatus of claim 26 wherein the series of high and low values in each of the pulse patterns within the first and second set of pulse patterns are of equal length.

20

28. The apparatus of Claim 26 wherein the high values in each of the pulse patterns within the first set of pulse patterns do not overlap in time with the high values in each of the pulse patterns within the second set of pulse patterns.

25

29. The apparatus of Claim 24 wherein the first set of pulse patterns includes two different pulse patterns and wherein the second set of pulse patterns includes two different pulse patterns.

30

30. The apparatus of Claim 24 wherein the number of first pattern groups within the first frequency orthogonal code division multiplexed excitation waveform and the number of second pattern groups within second frequency orthogonal code division multiplexed excitation waveform are prime numbers.

31. The apparatus of Claim 30 wherein there is a total of three first pattern groups within the first frequency orthogonal code division multiplexed excitation waveform and a total of two second pattern groups within second frequency orthogonal code division multiplexed excitation waveform, and wherein each first pattern group
- 5 includes four pulse patterns selected from the first set of pulse patterns and each second pattern group includes six pulse patterns selected from the second set of pulse patterns.